

## **APPENDIX F.1**

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### **Description of the Land-Based Test Facility**

**By**

**Hanla IMS Co., Ltd.**

**Republic of Korea**

**EcoGuardian™ Ballast Water Management System  
For  
Final Approval**

## **CONTENTS**

<b>1</b>	<b>INFORMATION OF THE LAND-BASED TEST .....</b>	<b>2</b>
1.1	Operating Information .....	2
1.2	Test Modes .....	3
1.3	Location of the Land-Based Test Site.....	5
1.4	Pictures of the Land-Based Test Facility.....	6
<b>2</b>	<b>DESCRIPTION OF MAIN UNITS.....</b>	<b>9</b>
2.1	Filter Unit.....	9
2.2	Electrochlorination Unit .....	10
2.3	Neutralization Unit .....	17
2.4	TRO Sensor Unit .....	19
2.5	Main Control Unit.....	21
2.6	Power Distribution Unit.....	23
2.7	Human Machine Interface (HMI) .....	23

## 1 INFORMATION OF THE LAND-BASED TEST

### 1.1 Operating Information

The operating information in the land-based test is shown in Table 1.1.

**Table 1.1: Operating information in the land-based test**

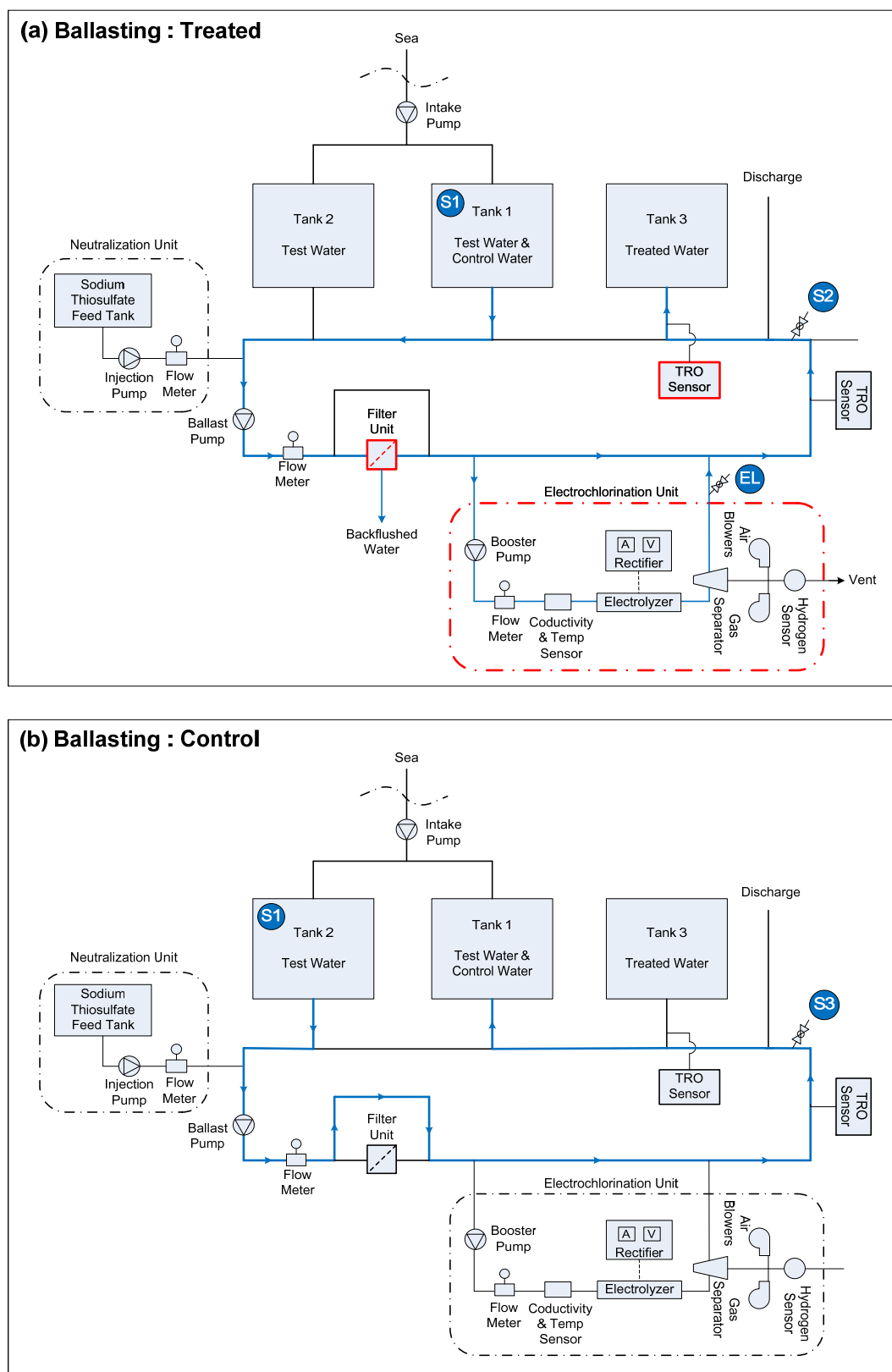
	Seawater	Brackish water
Test period	18/04/2012 ~ 21/05/2012	23/05/2012~26/06/2012
Test cycle	Cycle 1~5 (5 weeks)	Cycle 6~10 (5 weeks)
Salinity	34 PSU	21 PSU
Ballast flow rate	250 ± 10 m <sup>3</sup> /h	
Treated volume	- Treated : 250 m <sup>3</sup> - Control : 250 m <sup>3</sup>	
Side-stream flow rate	2.5 ± 0.2 m <sup>3</sup> /h	
Maximum TRO concentration at the ballast line	9 mg/L	
Maximum TRO concentration at the side-stream	900 mg/L	
Neutralizer chemical	Sodium thiosulfate (Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> )	
Power consumption	11.1 kW (300 A, 37 V)	14.7 kW (334 A, 44 V)

**Table 1.2: Equipment list of the land-based test facility**

Equipment	Description	Specification
Tank 1	Test water tank & control water tank	- Volume: 300m <sup>3</sup> - Size: 8,500 x 9,000 x 3,900
Tank 2	Test water tank	- Volume: 300m <sup>3</sup> - Size: 8,500 x 9,000 x 3,900
Tank 3	Treated water tank	- Volume: 300m <sup>3</sup> - Size: 8,500 x 9000 x 3,900
Fresh water tank	For making brackish water and cleaning tanks	- Volume: 200m <sup>3</sup> - Size: 8,500 x 6,000 x 3,900
Ballast pump	For simulating ballast pump	- Centrifugal type - Max. 300m <sup>3</sup> /h x 30m
Flow meter	Measures the main ballasting flow rate	- Electromagnetic type
Main pipe	Ballasting line De-ballasting line	- Material: Hot-dip galvanized steel pipe - Nominal diameter: 200A
Valves	Open or close the lines remotely	- Pneumatic type

## 1.2 Test Modes

The flow diagram of the land-based test facility is shown in Figure 1.1.



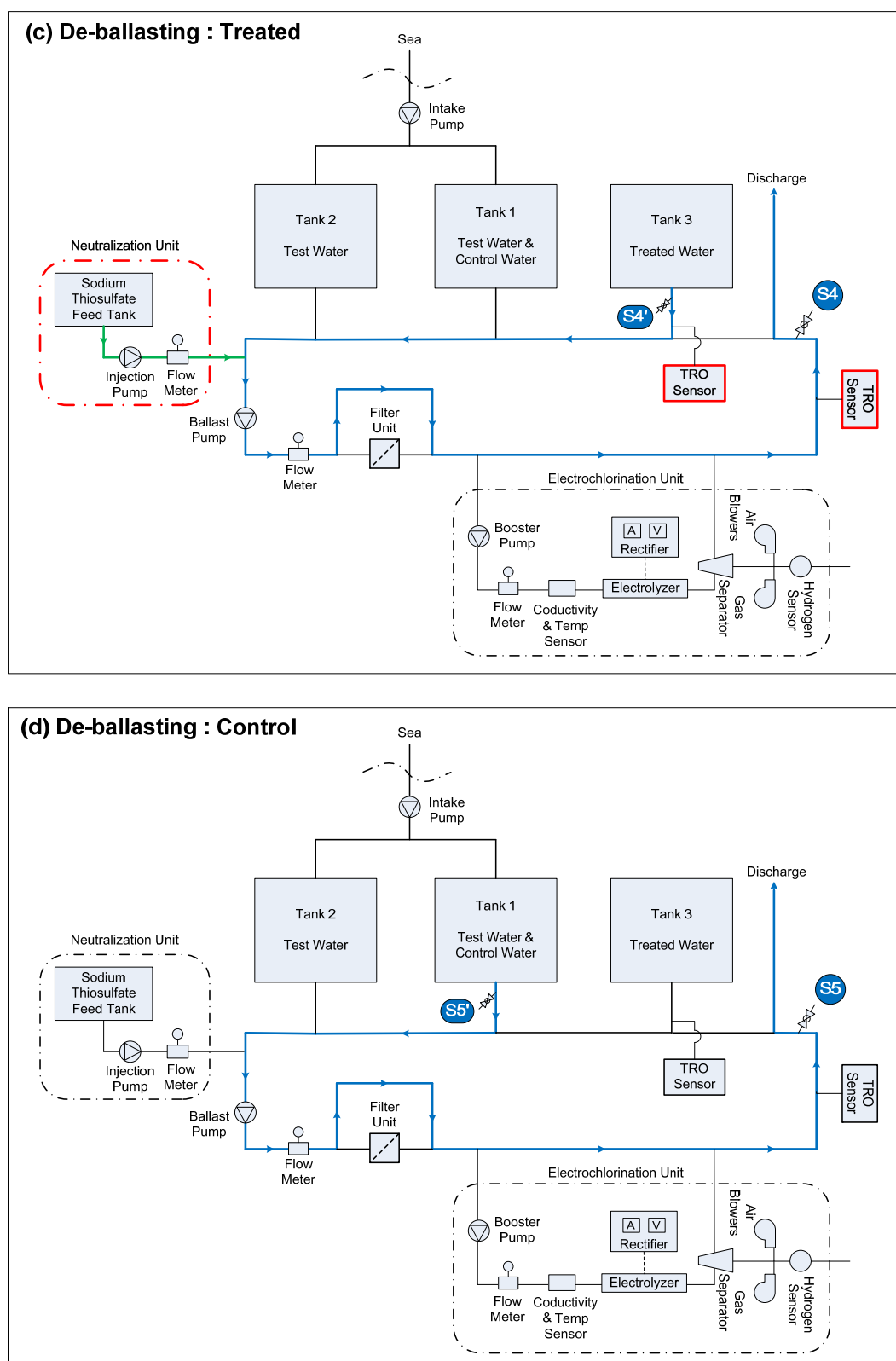


Figure 1.1: Diagram of flow and sampling points

### 1.3 Location of the Land-Based Test Site

- Address: 1048-4, Oryun-ri, Dosan-myeon, Tongyeong-si, Gyeongsangnam-do, Republic of Korea
- Location: Latitude 34° 54' 31. 01" N, Longitude 128° 18' 55. 09" E

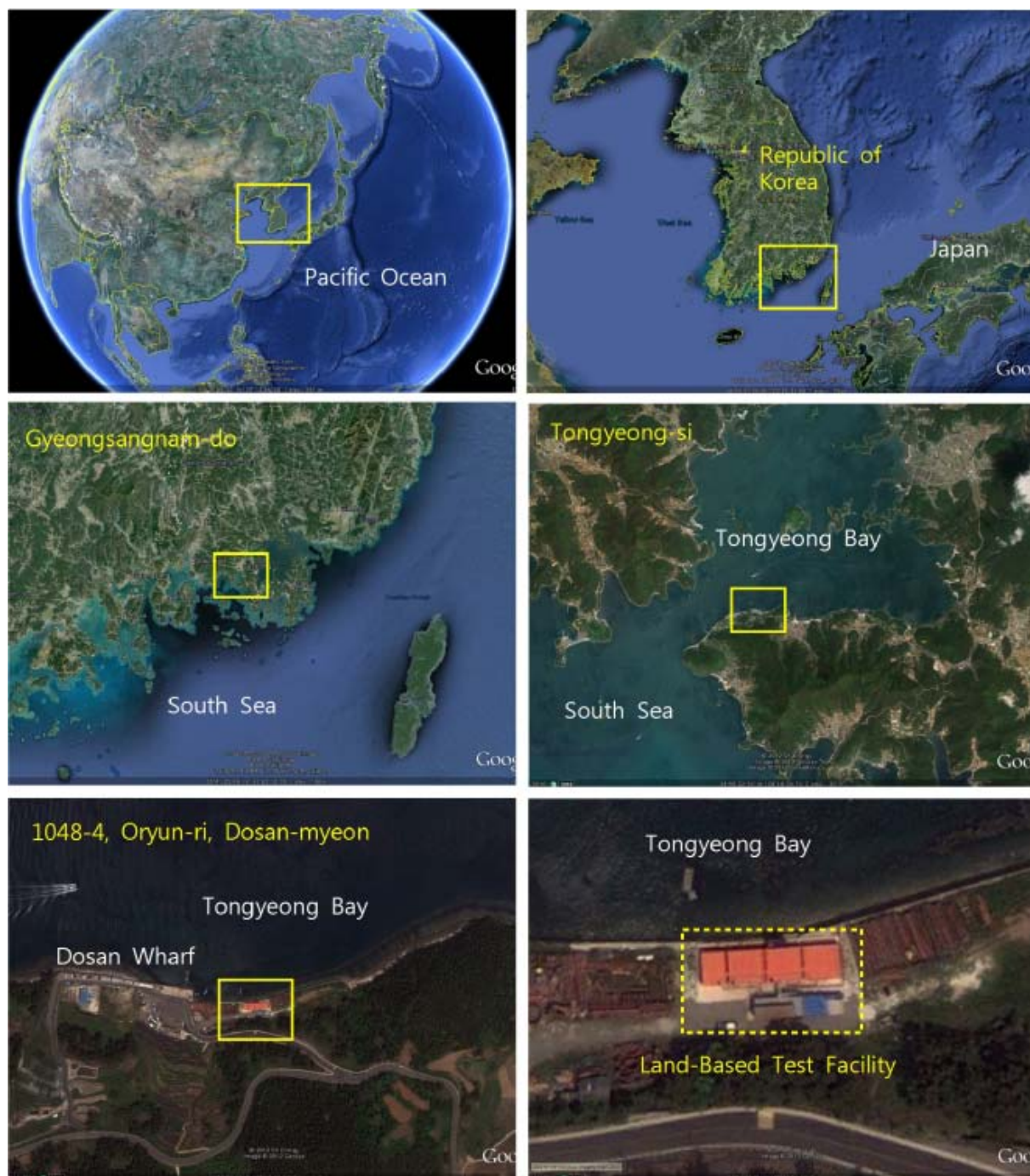


Figure 1.2: Location of the land-based test site

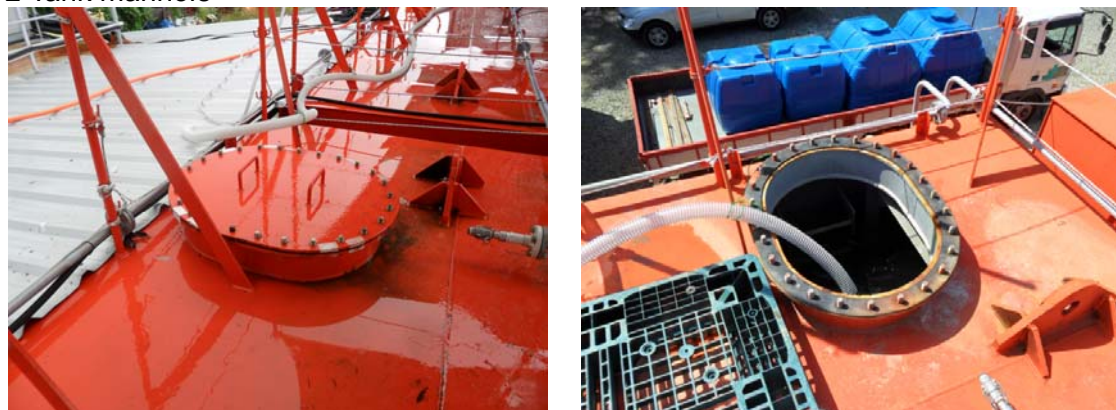


## 1.4 Pictures of the Land-Based Test Facility

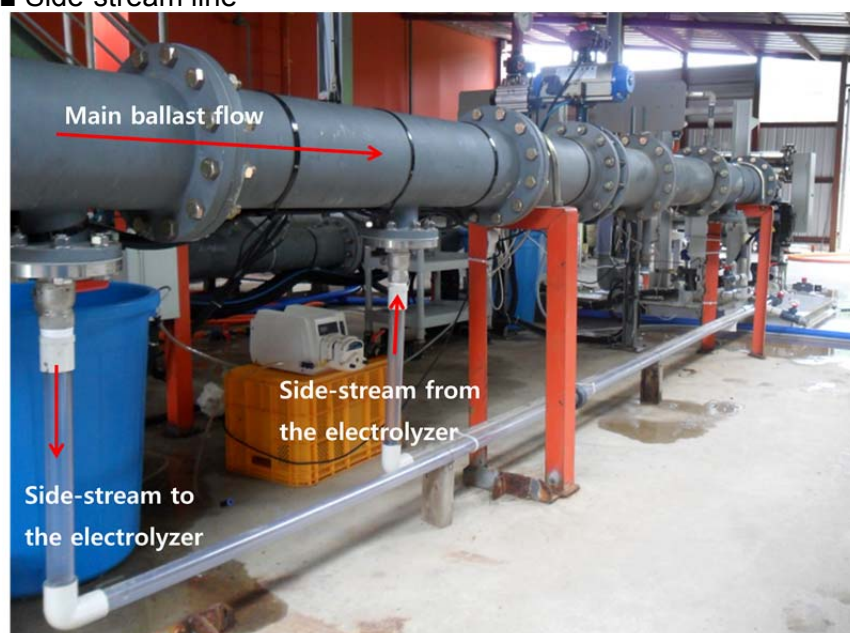
### ■ Test tanks



### ■ Tank manhole

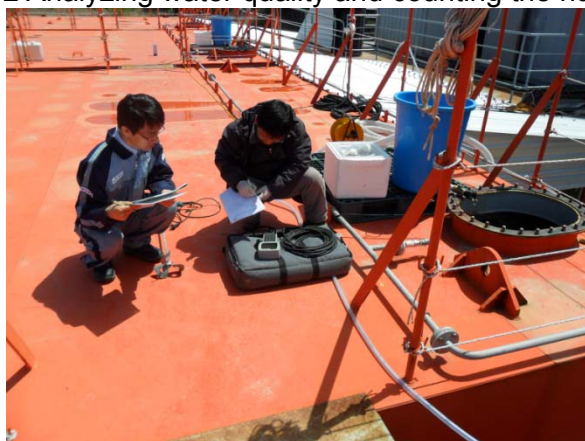


### ■ Side-stream line



**■ Sampling port****■ Sampling tanks****■ Netting****■ Port for the feeding water to TRO sensor****■ Port for injecting the neutralizer solution**

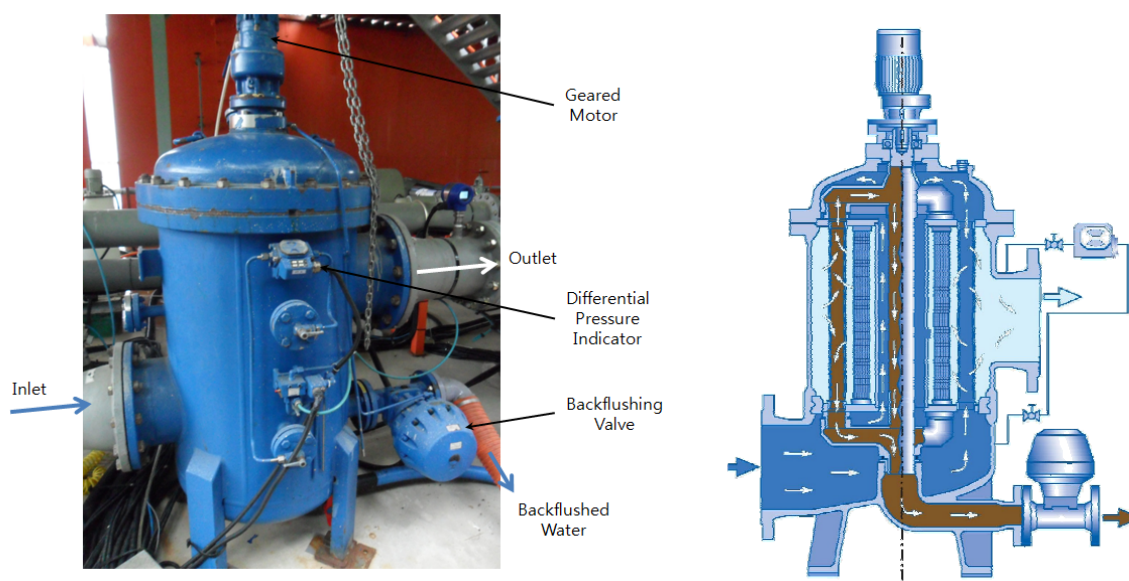


**■ Analyzing water quality and counting the number of micro-organisms at the test site****■ Measuring the TRO concentration using FAS titration method****■ Overview of the land-based test facility**

## 2 DESCRIPTION OF MAIN UNITS

No.	Unit Name	Q'ty	Description
1	Filter Unit	1	- Removes organisms and solid particles larger than 50 µm - Automatic backflushing function
2	Electrochlorination Unit	1	Produces disinfectant sodium hypochlorite and injects it to the main ballast line
3	Neutralization Unit	1	Neutralizes the residual TRO before discharging ballast water
4	TRO Sensor Unit	2	Measures TRO concentration during ballasting and de-ballasting
5	Main Control Unit	1	- Controls system operation with PLC
6	Power Distribution Unit	1	Distribute electrical power to all system and breaks power at the extraordinary situation
7	HMI (Human Machine Interface)	1	- Activates / deactivates system - Monitors signals from all units and sensors - Data logging

### 2.1 Filter Unit



**Figure 2.1: Filter unit in the land-based test**

During ballasting, the ballasting water is first pumped through the automatic backflushing filter unit which removes large organisms and solid particles.

The filter operates only during ballasting. During de-ballasting, the filter is bypassed.

The backflushing is automatic and does not interrupt the filtration process.

While some filter elements are cleaned by backflushing in a rotating sequence, the remaining filter elements continue filtrating. Minimum differential pressure required to backflush is 0.5 bar.

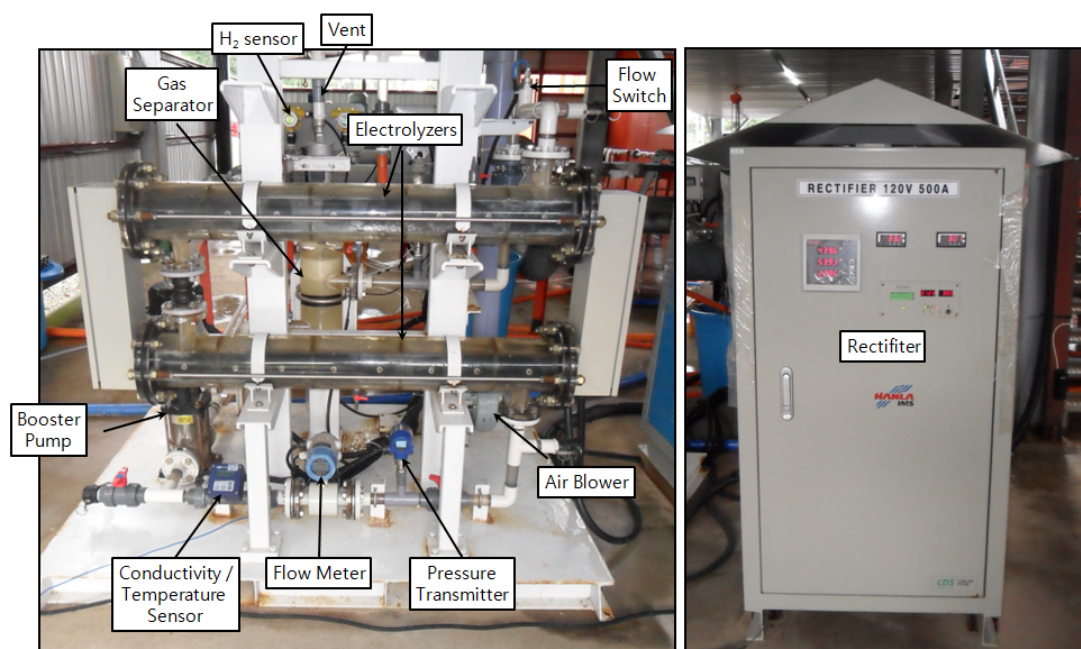
The filter performs an automatic backflushing operation during filtering operation. A pressure differential indicator monitors the pressure difference between the inlet and outlet of water flow. When the difference reaches the pre-set value (0.5 bar), an automatic backflushing operation starts. If the differential pressure is still too high after self-cleaning, the backflush sequence is repeated.

A motor rotates an upper and lower flushing arm and connects backpressure to each filter element. Dirty element is backflushed and cleaned. This process is carried out consecutively in a rotating sequence.

**Table 2.1: Specification of the filter unit**

Process Data	Working fluid	Seawater or brackish water
	Flow rate	200~300m <sup>3</sup> /h
	Operating pressure	2.0 bar
	Allowable operating pressure	10.0 bar
	Allowable operating temperature	0 ~ 60°C
	Filtration degree	50 µm
	Pressure drop	Max. 0.5 bar
Filter Element	Element type	Screen mesh
Material	Housing	Carbon steel with internal rubber liner
	Filter element	316 Stainless steel or super and duplex
Electrical	Power supply	440V 3P
	Enclosure	IP56
Valve	Backflush valve	Pneumatic type

## 2.2 Electrochlorination Unit



**Figure 2.2: Electrochlorination unit in the land-based test**



The side stream of ballasting water goes through the electrochlorination unit that generates TRO of high concentration. The concentrated stream is then injected back to the main ballasting line.

After injection, the high concentrated TRO is mixed and diluted with the main ballasting water and goes to ballast tanks.

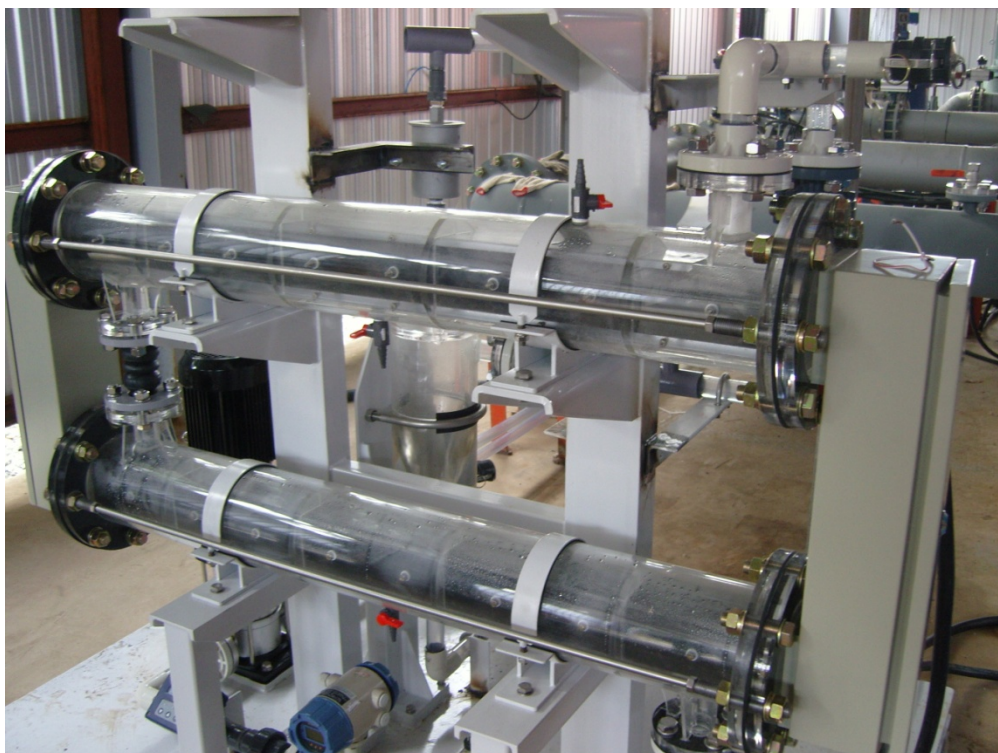
Maximum dose concentration is 9 mg/L TRO as  $\text{Cl}_2$  which is controlled by using the on-line TRO sensor. That is, EcoGuardian™ system adjusts the supplying current which determines hypochlorite production rate at the electrochlorination cells by monitoring TRO sensor.

**Table 2.2: Components of the electrochlorination unit**

No.	Component	Description	Specification
1	Electrolyzer	Produces sodium hypochlorite	- 2 SET - Electrode: MMO coating
2	Booster pump	Increases the side-stream line pressure to inject sodium hypochlorite into the main ballast line.	- Centrifugal, vertical type - Max $5\text{m}^3/\text{h}$ X 50m
3	Flow meter	Measures side-stream flow rate	- $0\sim 10\text{ m}^3/\text{h}$
4	Conductivity / Temp. sensor	Measures salinity and temperature of the water incoming to electrolyzer.	- $0\sim 100\text{ mS/cm}$
5	Pressure Transmitter	Monitors the pressure in the side-stream line	- $0\sim 10\text{ kgf/cm}^2$
6	Flow switch	Detect filling of water in the electrolyzer to prevent unwanted power supply in dry condition	- Vibrating or ultrasonic type
7	Gas separator	Separates hydrogen gas produced in electrochlorination process.	- Hydrocyclone type
8	Auto air vent head	Discharges hydrogen gas separated by gas separator	
9	Air blower	Dilutes hydrogen gas to less than 1% by forced air blowing and vented to atmosphere	- Non-sparking material
10	Rectifier	Supplies DC current to the electrolyzer	- Capacity : 60 kW (120V, 500A)



### 2.2.1 Electrolyzer



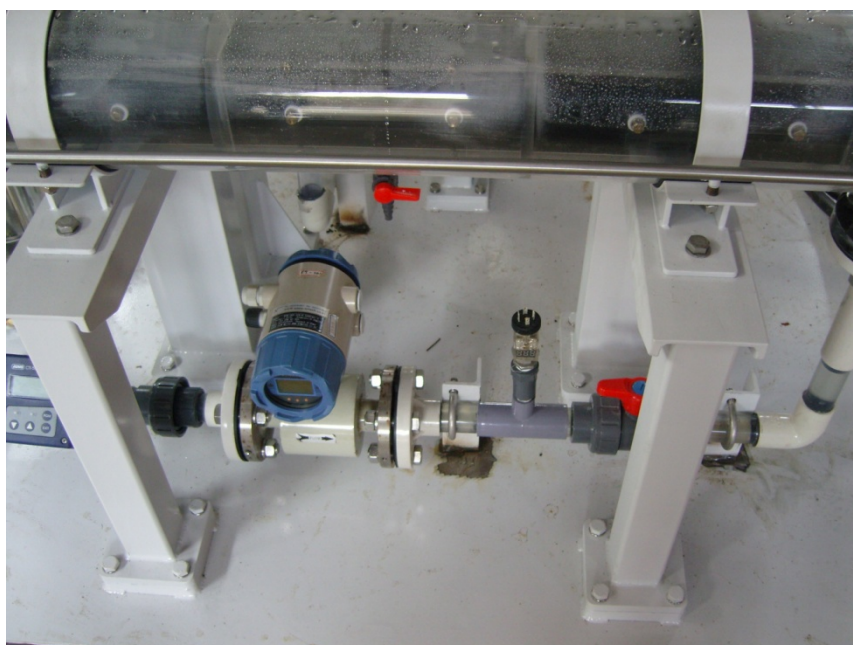
### 2.2.2 Booster pump



Pump Type	Vertical Multi-Stage Volute Pump		
OPERATING CONDITIONS		ELECTRIC MOTOR	
Liquid	Water	Output	2.2 kW
Capacity	83 L/min	No. of Pole	2
Total Head	50 m	Motor Speed	3450 rpm

Differential Pressure	5 Kg/cm <sup>2</sup>	Phase	3	Frequency	60 Hz
Pump Efficiency	59.5 %	Voltage	380 V	Ampere	4.9 A
CONSTRUCTIONS		MATERIALS			
Mounting	Foot	Casing		Stainless Steel 14	
Split	Radial	Impeller		Stainless Steel 316	
Suction, Discharge	32 mm	Shaft		Stainless Steel 316	
Installation	Indoor	Casing Ring		TEFLON	
Impeller	Close	Stage Casing		Stainless Steel 14	
No. of Stage	6	Coupling		Grey Casting 200	
Rotation Viewed Driver	CCW	WEIGHTS			
Coupling	Half(Rigid & Split)	Pump		19.2 Kg	
Transmission	Direct	Driver		23 Kg	
Shaft Seal	Mechanical Seal	Total		42.2 Kg	

### 2.2.3 Flow Meter



Size	200 mm, 32 mm
Connection	Standard JIS 10K Flange
Measuring Range	0.1 m/s ~ 10 m/s
Flow Velocity	0.3 m/s ~ 10 m/s
Accuracy	± 0.5% F.S. (0.3 m/s ~ 10 m/s ) ± 1.0% F.S. (0.01 m/s ~ 0.3 m/s )
Ambient Temperature	-10°C ~ 60°C

Conductivity	>5 $\mu\text{S}/\text{cm}$
Power Supply	AC 220V (60Hz)
Power Consumption	15VA
Display	LCD Display Flowrate : 5 digit Display Total : 9 digit Display With Back Light
Output	Analog : DC 4 ~ 20mA Pulse : DC 16 ~ 30V (Open collector pulse) Digital : RS485 (Option)
Material	
Head	Cast Aluminum
Body	Stainless Steel 316
Lining And Sealing	Hard Rubber
Electrode	Hastelloy-C

## 2.2.4 Conductivity / Temperature Sensor



Type	Inductive Transmitter/Switching Device for Conductivity/Concentration and Temperature
Measuring Range	0 ~ 100 mS/cm
Tolerance	$\leq 0.5\%$
Power Supply	DC 24V
Power Consumption	$\leq 3\text{W}$
Connection	2.5 mm <sup>2</sup>
Accuracy	$\leq 0.5\%$ of Measuring Range



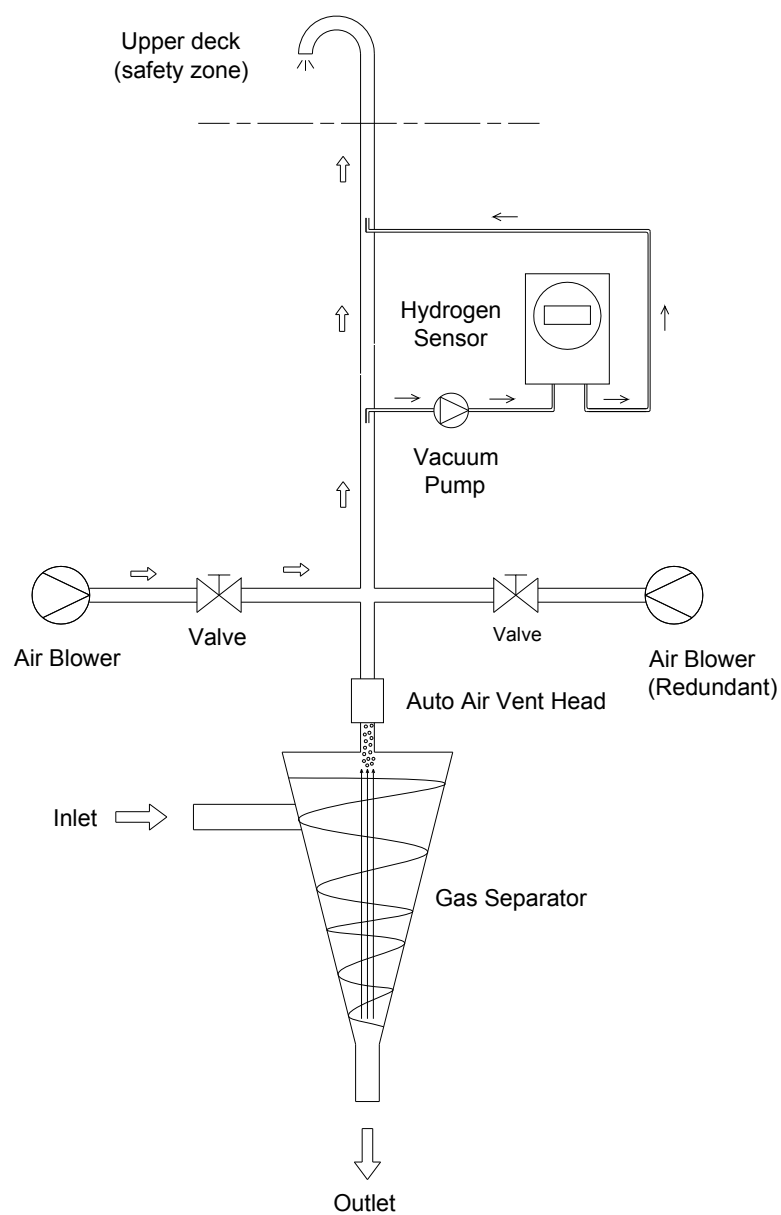
Ambient Temperature	-5 ~ +50°C
Storage Temperature	-10 ~ +75°C
Enclosure Protection	IP67
Housing	Polyamide(PA)
Weight	Approx. 0.3 ~ 2 kg
Output Signal For Conductivity	4 ~ 20mA
Output Signal For Temperature	4 ~ 20mA
Temperature Measuring Range	-20 ~ 150°C
Accuracy	≤ 0.5%
Pressure	10 bar max. at 20°C 6 bar max. at 60°C

### 2.2.5 Hydrogen gas sensor

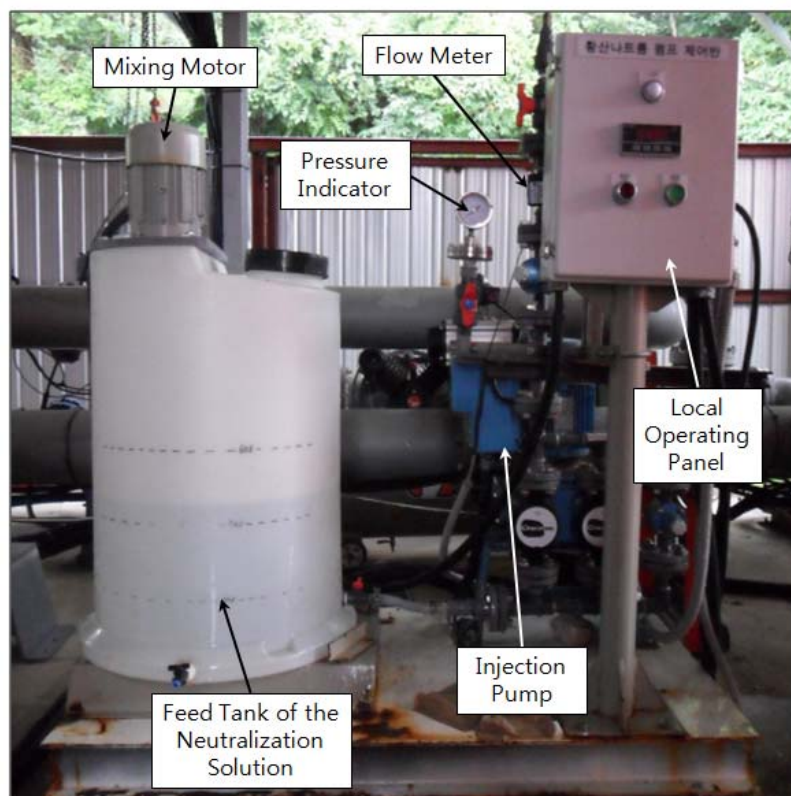


Sensor Type	CAT Bead Sensor
Selectable Gas Ranges	100% LEL only
Resolution	1% LEL
Transmitter Material	Expoxy painted LM25 Aluminium, Stainless Steel 316
Sensor Material	Sensor Material Stainless Steel 316
Operating Temperature	-40°C ~ 65°C
Operating Pressure	0.9 ~ 1.1 bar
Explosion Proof	ATEX Ex II 2 GD Ex d IIC Gb T6(Ta -40°C to +65°C) Ex tb IIIC T85°C Db IP66
EMC	EN50270:2006 EN6100-6-4:2007



**Hydrogen Degassing System**

## 2.3 Neutralization Unit



**Figure 2.3: Neutralization unit in the land-based test**

During de-ballasting, the de-ballasting water is neutralized by the neutralization unit prior to discharging overboard.

Sodium thiosulfate as neutralizer chemical is injected into the de-ballasting line to neutralize the residual TRO. The injection rate of sodium thiosulfate is controlled by monitoring de-ballasting flow rate and residual TRO concentration.

Two TRO sensors are used to measure the residual TRO concentration at two points, before and after the neutralization.

One TRO sensor is used to measure the residual TRO concentration before the neutralization, according to this sensor value the EcoGuardian™ controller determines the injection rate of neutralizer solution into the de-ballasting line.

The other TRO sensor after the neutralization is used to check that residual TRO has been neutralized properly.

The neutralization unit of EcoGuardian™ maintains MADC (Maximum Allowable Discharge Concentration) for 0.2 mg/L TRO as  $\text{Cl}_2$ .

To comply with this condition, dosing 2.5 parts of sodium thiosulfate to 1 part chlorine is proper.

**Table 2.3: Components of the neutralization unit**

No.	Name	Description	Specification
1	Feed tank of the neutralizer solution	Stores and feeds the solution of the neutralizer solution	- Material: polyethylene (PE)
2	Injection pump	Controls the Injection rate of the neutralizer solution into the main de-ballasting line	- Diaphragm pump - Max 0.5 L/min - Max. 10 bar
3	Flow meter	Monitors the injection rate. RPM of the injection is feedback-controlled	- 0~1.0 L/min
4	Mixing motor	Mixes pellet type of sodium thiosulfate with water	- 60 rpm
5	Pressure transmitter	Monitors the pressure in the injection line	- 0~10 kgf/cm <sup>2</sup>

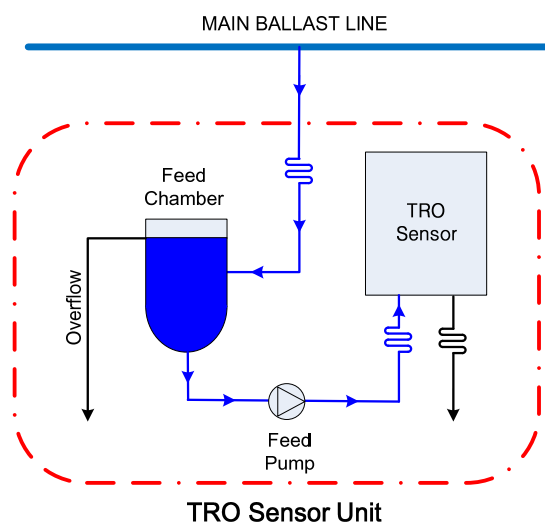
### 2.3.1 Injection pump



PUMP SPECIFICATION		CONSTRUCTION	
Capacity	Max. 520 mL/min	Diaphragm Type	Mechanical
Pressure	Max. 10 bar	Head No.	Double
Stroke Speed(60Hz)	58 S.P.M	Motor Mounting	Vertical
Diaphragm Diameter	Φ55	Suction Size	KS 10K 15A RF/LJ
Stroke Length	6 mm	Discharge Size	KS 10K 15A RF/LJ
AC INDUCTION MOTOR SPEC.		MATERIAL	
Enclosure	TEFC	Head	PVC

Rated output	0.4 kW	Diaphragm	PTFE
Power	380V/3Φ/60Hz	Check Ball	Ceramic
Pole / Speed	8P / 1750 rpm	Ball Guide, Seat	PVC
Insulation Class	B		
Protection Degree	IP 54		
Input Signal	4 ~20 mA		
Output Signal	4 ~20 mA		

## 2.4 TRO Sensor Unit



**Figure 2.4: TRO sensor unit**

The EcoGuardian™ system controls and measures TRO concentration using on-line type TRO sensor based on the DPD method. This sensor is designed to measure for the range of TRO concentrations up to 10 mg/L, TRO as Cl<sub>2</sub>.

A redundant TRO sensor shall be prepared to cope with the malfunction of the installed TRO sensor.

**Table 2.4: The components of the TRO sensor unit**

No.	Component	Description	Q'ty	Specification
1	TRO sensor	Measures the concentration of TRO as Cl <sub>2</sub>	1	- 0~10 mg/L as Cl <sub>2</sub> - DPD colorimetric method
2	Feed chamber	Maintains the stable flow rate & pressure of feeding water to the TRO sensor	1	- Transparent C-PVC
3	Feed pump	Feeds seawater to the TRO sensor	1	- 0~1.0 L/min



### 2.4.1 TRO Sensor



**Figure 2.5: TRO sensor**

**Table 2.5: Specification of TRO sensor**

Measuring method	DPD colorimetric method (4500-Cl G)
Measuring range	0~10.00 mg/L (PPM)
Accuracy	±5% of reading or ±0.03mg/L (PPM) whichever is greater for range of 0~6.0mg/L (PPM) ±10% of reading from 6.01~10.00 mg/L (PPM)
Resolution	0.01 mg/L (PPM)
Cycle Time	Adjustable: Min.60 seconds Note : the system defaults to 2.5minutes
Display	Multi-Line Liquid Crystal Backlit Display
Alarms	Two Programmable, 120~240VAC 2A Form C Relay
Analog Output	Powered 4~20 mA, 600 Ω drive, isolated
Communications Port	Bi-directional RS-485 with Modbus
Maximum Water Pressure	Integral pressure regulator 0.34 bar(5.0PSI) to 10.3 bar (150PSI)
Flow Rate to Waste	200~400 ml/min.
Operating Temperature	5~40°C (41~104°F)
Wetted Materials	PVC, Borosilicate Glass, Reslyn (FFKM), Viton ® (FKM), Polypropylen, Stainless Steel, Acetal, Noryl®, Silicone
Sample Temperature Range	5~40°C (41~104°F)
Power Supply	100~240 VAC, 47~63 Hz, 150VA
Insulation Rating	Double Insulated, Pollution Degree 2, Overvoltage Category II
Environmental Conditions	Not recommended for outdoor use.

	Altitude up to 2000 meters Up to 95 % RH (Non-condensing)
Enclosure Rating	Designed to meet IP66/NEMA 4X
Regulatory Compliance And Certifications	CE Approved, ETL listed to UL 3111-1 & ETL Certified to CSA 22.2 No. 1010-1-92
Shipping Weight	2.5 kg (5.5 lbs.)

## 2.5 Main Control Unit

Main Control Unit has PLC which is connected with the electrochlorination unit or remote control panel. This unit can be installed at the most appropriate place for every specific vessel.

Main control panel and transformer/rectifier can be installed in one cabinet or in several cabinets separately.



**Figure 2.6: Main control unit**

- 4~20mA input / output signal
- Digital (RS232/485) input/output signal
- All units (Filter, Electrochlorination, Neutralization)
- System condition monitoring and alarm signal

**PLC Specifications**

- High Processing Speed
- Max. 284 I/O control supporting small & mid-sized system implementation
- Enough program capacity
- Expanded applications with the support of floating point.
- Easy attachable/extensible system for improved user convenience
- Optimized communication environment
- Integrated programming environment

Ambient Temperature	0 ~ 55°C		
Storage Temperature	-25 ~ +70°C		
Ambient Humidity	5 ~ 95%RH(Non-condensing)		
Storage Humidity	5 ~ 95%RH(Non-condensing)		
Vibration Resistance	Frequency	Acceleration	Pulse width
	$10 \leq f \leq 57\text{Hz}$	-	0.035mm
	$57 \leq f \leq 150\text{Hz}$	$4.9 \text{ m/s}^2 (0.5\text{G})$	-
Square Wave Impulse Noise	±500V		
Electrostatic Discharge	4kV		
Radiated Electromagnetic Field Noise	80 ~ 1000MHz, 10V/m		
Operating Ambience	Free from corrosive gases and excessive dust		
Altitude	Up to 2,000m		
Pollution Level	Less than 2		
Cooling	Air-cooling		

## 2.6 Power Distribution Unit



Figure 2.7: Power Distribution Unit

- Provides 220V/440V AC power and 24V DC power
- Provides power to LOP(Local Operation Panel) and equipments

## 2.7 Human Machine Interface (HMI)

- Activating and deactivating all units and sensors
- Monitoring the signals from all units and sensors
- Showing alarm, emergency situations
- Data logging of all units and sensors and making test report automatically

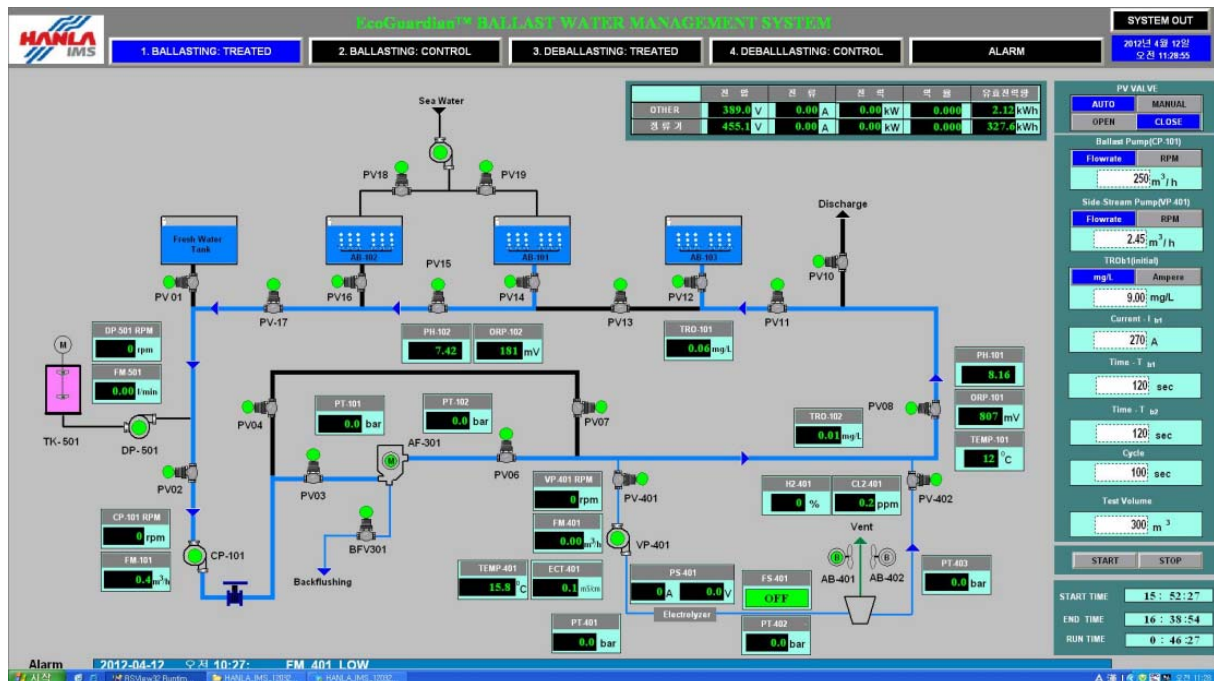




Figure 2.8: HMI display in the land-based test

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	Filename		BT-2012-0502-1																						
2	Mode		Ballast-Treated																						
3	Date		2012-05-02(Wen)																						
4	Start Time		12:36:9																						
5	End Time		13:36:53																						
6	Run Time		1:0:44																						
7																									
8	No	Time [hh:mm:ss]	FM-101 [m <sup>3</sup> /hr]	PT-101 [bar]	PT-102 [bar]	TEMP-101 [°C]	TRO-101 [mg/L]	AF-301 [sec]	FM-401 [m <sup>3</sup> /hr]	ECT-401 [mS/cm]	I [A]	V [V]	H2-401 [%LEL]	CL2-401 [ppm]	PT-401 [bar]	PT-402 [bar]	PT-403 [bar]	I <sub>1</sub> [A]	T <sub>11</sub> [sec]	T <sub>12</sub> [sec]	Cycle [sec]	FM-501 [L/min]	TRO-102 [mg/L]	C <sub>10</sub> [%]	SR
9	0	12:36:29.812	70.90	0.30	0.10	15.00	0.06	17.00	0.03	49.20	0.00	0.00	0.00	0.20	0.00	0.00	0.00	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
10	1	12:36:30.765	71.50	0.30	0.00	15.10	0.04	17.00	0.03	49.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
11	2	12:36:31.765	70.90	0.40	0.00	15.00	0.05	17.00	0.02	49.20	0.00	0.00	0.00	0.00	0.10	0.00	0.00	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
12	3	12:36:32.765	70.60	0.40	0.10	15.00	0.05	17.00	0.33	49.30	0.00	0.00	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
13	4	12:36:33.765	72.00	0.40	0.10	15.00	0.05	17.00	0.50	49.30	0.00	0.00	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
14	5	12:36:34.765	73.20	0.60	0.20	14.90	0.04	17.00	0.51	49.40	0.00	0.00	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
15	6	12:36:35.765	73.50	0.50	0.20	15.10	0.05	17.00	0.50	49.40	0.00	0.00	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
16	7	12:36:36.765	74.70	0.50	0.30	15.00	0.05	17.00	0.48	49.50	0.00	0.10	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
17	8	12:36:37.765	78.30	0.60	0.30	15.10	0.05	17.00	0.46	49.50	0.00	0.10	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
18	9	12:36:38.765	86.60	0.70	0.30	15.00	0.04	17.00	0.45	49.60	0.00	0.10	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
19	10	12:36:39.765	91.80	0.70	0.30	15.10	0.04	17.00	0.17	49.60	0.00	0.10	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
20	11	12:36:40.765	96.80	0.70	0.40	15.20	0.04	17.00	0.18	49.60	0.00	0.10	0.00	0.20	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
21	12	12:36:41.765	102.10	0.80	0.40	15.10	0.04	17.00	0.22	49.60	0.00	0.10	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
22	13	12:36:42.765	108.00	0.80	0.40	15.00	0.05	17.00	0.28	49.40	0.00	0.10	0.00	0.10	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
23	14	12:36:43.765	113.20	0.90	0.40	15.00	0.04	17.00	0.31	49.20	0.00	0.20	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
24	15	12:36:44.765	119.00	0.80	0.40	15.00	0.04	17.00	0.30	48.70	0.00	0.10	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
25	16	12:36:45.765	123.10	0.90	0.50	14.90	0.05	17.00	0.29	48.20	175.00	24.70	0.00	0.30	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
26	17	12:36:46.765	129.90	0.90	0.50	15.10	0.04	17.00	0.25	47.70	213.00	29.00	1.00	0.10	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
27	18	12:36:47.765	136.60	0.90	0.50	15.00	0.05	17.00	0.09	47.30	230.00	30.10	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
28	19	12:36:48.765	141.80	0.90	0.50	14.90	0.04	17.00	0.03	47.10	247.00	31.20	0.00	0.00	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
29	20	12:36:49.765	148.50	0.90	0.50	15.10	0.05	17.00	0.02	46.90	251.00	31.50	0.00	0.10	0.10	0.00	0.10	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
30	21	12:36:50.765	154.30	1.00	0.50	15.10	0.05	17.00	0.01	46.80	255.00	31.90	0.00	0.10	0.10	0.00	0.20	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
31	22	12:36:51.765	159.80	1.00	0.60	15.00	0.05	17.00	0.03	46.70	260.00	32.40	0.00	0.00	0.10	0.00	0.20	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
32	23	12:36:52.765	162.90	1.10	0.60	15.00	0.04	17.00	0.03	46.60	265.00	32.90	0.00	0.30	0.10	0.00	0.20	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
33	24	12:36:53.765	165.40	1.10	0.60	15.00	0.05	17.00	0.02	46.50	266.00	33.10	0.00	0.00	0.10	0.00	0.20	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
34	25	12:36:54.765	165.30	1.10	0.60	15.00	0.04	17.00	0.02	46.40	270.00	33.70	0.00	0.00	0.10	0.00	0.20	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
35	26	12:36:55.765	165.80	1.10	0.60	15.00	0.04	17.00	0.02	46.30	275.00	34.10	0.00	0.20	0.10	0.00	0.20	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
36	27	12:36:56.765	166.90	1.00	0.70	15.10	0.05	17.00	0.02	46.20	278.00	34.40	0.00	0.10	0.10	0.00	0.20	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50
37	28	12:36:57.765	170.00	1.10	0.70	15.00	0.05	17.00	0.02	46.10	282.00	34.80	0.00	0.10	0.10	0.00	0.20	300.00	120.00	300.00	180.00	0.00	0.00	24.82	2.50

Figure 2.9: Logged data in the land-based test